Citation:

Lau C, Toft U, Tetens I, Richelsen B, Jørgensen T, Borch-Johnsen K, Glümer C. Association between dietary glycemic index, glycemic load and body mass index in the Inter99 study: Is underreporting a problem? *Am J Clin Nutr.* 2006 Sep; 84 (3): 641-645. PMID: 16960180

PubMed ID: 16960180

Study Design:

Cross-Sectional Study

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the association between glycemic index (GI), glycemic load (GL) and body mass index (BMI), with a focus on the confounding factor of total energy intake and the effect of exclusion of low energy reporters (LERs).

Inclusion Criteria:

Study population: 30- to 60-year-old women and men from the Danish population-based Inter99 study.

Exclusion Criteria:

- Individuals who had not filled in the food-frequency questionnaire (FFQ), who had not answered any questions on five pages out of 14, or who had misunderstood the FFQ
- Those known to have diabetes and those with missing information on smoking status and physical activity were also excluded.

Description of Study Protocol:

Recruitment

- In 1999 the study population comprised 61,301 individuals born in 1939-1940, 1944-1945, 1949-1950, 1954-1955, 1959-1960, 1964-1965 and 1969-1970 who were resident in 11 municipalities in the southwestern part of Copenhagen County. All individuals were drawn from the Civil Registration System
- An age- and sex-stratified random sample of 13,016 persons was drawn from the study

population, and 12,934 persons were eligible for further examination. All these individuals were invited for a health survey at the Research Centre for Prevention and Health in Glostrup
- Baseline data were collected in 1999-2001 and 6,784 (52.5%) persons agreed to participate.

Design

Cross-sectional study.

Dietary Intake/Dietary Assessment Methodology

- The participants completed a self-administered 198-item FFQ on which they were asked to report their dietary intake during the previous month. The GI for carbohydrate-containing food items was estimated by using average GI values from the GI table by Foster-Powell, et al with white bread as the reference food. The calculation of daily GI and daily GL, the latter including available carbohydrates, was based on 78 different carbohydrate-rich food items with GI values ranging from 10 to 147
- Calculation of dietary intake was based on an updated version of the Danish Food Composition Data Bank
- The fixed cutoff used to identify LERs was an EI/BMR 1.14, which identifies the minimum plausible level of energy expenditure at the individual level when the dietary method covers intake for 28 days. Participants with an EI/BMR 1.14 were classified as being adequate energy reporters (AERs) or high energy reporters (HERs).

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- Three linear regression models were used to test for linear trend between each of the continuous explanatory variables GI and GL and the continuous response variable BMI. The residuals of the log-transformed residuals of BMI approximated a normal distribution a little better than the residuals of the non-transformed residuals, but the difference was not dramatic
    - First, univariate analyses were conducted (model 1)
    - Second, the confounding factors of sex, age, smoking, physical activity at work and during leisure time (categorical) and alcohol intake as a percentage of energy (continuous) were included. The researchers tested for interactions and found that sex in the entire population modified the effect of alcohol (P=0.05). Hence, the interaction term between sex and alcohol intake was included in this multivariate model (model 2)
    - Third, energy intake as a continuous variable was included in the model together with the interaction term sex energy intake (model 3), because sex modified the effect of energy intake (P=0.05)
- They also tested whether the categorical variable EI/BMR (including the LER and AER-HER groups) modified the effect of GI or GL on BMI. Significant interactions were observed for each of these univariate models (P=0.001). Stratified analyses of the categorical variable of EI/BMR were conducted together with analyses on the entire population by using SAS 8.2 (SAS Institute, Cary, NC). A P-value of 0.05 was considered significant.

Data Collection Summary:

Timing of Measurements

- Inter99 Study details can be found in the following references:
  - Jorgenson T, Borch-Johnsen K, Thomsen T, et al. A randomized non-pharmacological intervention study for prevention of ischaemic heart disease: Baseline results Inter99 (1). *Eur J Cardiovasc Prevent Rehab* 2003; 10: 377-386.
  - Glumer C, Jorgenson T, Borch-Johsen K. Prevalences of diabetes and impaired glucose regulation in a Danish population: The Inter99 study. *Diabetes Care* 2003; 26: 2,335-2,340.

Dependent Variables

- Glycemic index: Estimated by using white bread as the reference food
- Glycemic load: Estimated by using white bread as the reference food, including available carbohydrates
- BMI.

Independent Variables

- Total energy intake: Based on an updated version of the Danish Food Composition Data Bank
- Exclusion of low energy reporters.

Control Variables

None.

Description of Actual Data Sample:

- *Initial N:* 12, 934
- *Attrition (final N):* 6,334
- *Age:* 46.1+7.8 years
- *Ethnicity:* Not given
- *Other relevant demographics:*
  - Low energy reporters (LERs): 24.7%
  - Daily smokers: 35.5%
  - Physically inactive: 34.8%
- *Anthropometrics:*
  - BMI: 26.2+4.6kg/m^2
  - Basal metabolic rate: 1,645+255kcal per day
  - Energy intake: 2,331+823kcal per day
  - EI/BMI: 1.48+0.51
- *Location:* Research Centre for Prevention and Health, Glostrup, Denmark.

Summary of Results:

	Change in BMI (kg/m^2) (95%CI)			
	Glycemic index	**P**	**Glycemic index**	**P**

Entire population (N=6,334)				
Model 1	-0.061(-0.241, 0.119)	0.505	-0.066 (-0.102, -0.030	<0.001
Model 2	0.074(-0.137, 0.284)	0.492	-0.084 (-0.121, -0.047)	<0.001
Model 3	0.261(0.047, 0.476)	0.017	0.173 (0.095, 0.252)	<0.001
Adequate and high energy reporters (N=4,679)				
Model 1	0.054 (-0.137, 0.246)	0.578	0.100 (0.061, 0.138)	<0.001
Model 2	0.361(0.137, 0.584)	0.002	0.098 (0.058, 0.138)	<0.001
Model 3	0.290 (0.061, 0.520)	0.013	0.139 (0.064, 0.214)	<0.001
Low energy reporters (N=1,565)				
Model 1	0.331(-0.064, 0.725)	0.101	0.998 (0.819, 1.177)	<0.001
Model 2	0.153 (-0.309, 0.615)	0.517	1.018 (0.821, 1.215)	<0.001
Model 3	-0.131(-0.571, 0.310)	0.561	0.011(-0.310, 0.331)	0.949

Key Findings

- In the univariate analyses of the entire population, GL was inversely associated with BMI
- No association was observed for GI
- After full adjustment (including energy intake), both GI and GL were positively associated with BMI
- When LERs were excluded, GL was positively associated with BMI in all analyses and GI was positively associated with BMI in the multiple analyses.

Author Conclusion:

- There was a positive association between GI, GL and BMI
- Energy adjustment and the exclusion of LERs significantly affected the results of the analysis
- Generally, studies reporting associations between GI, GL and BMI should be interpreted carefully.

Reviewer Comments:

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes

3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes

3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	???
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A

6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	No
7.1.	Were primary and secondary endpoints described and relevant to the question?	N/A
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	No
7.6.	Were other factors accounted for (measured) that could affect outcomes?	N/A
7.7.	Were the measurements conducted consistently across groups?	N/A
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	???
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes

10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes